

# DATA SHEET

**BFG425W**

**NPN 25 GHz wideband transistor**

Product specification  
Supersedes data of 1997 Oct 28  
File under Discrete Semiconductors, SC14

1998 Mar 11

## NPN 25 GHz wideband transistor

## BFG425W

## FEATURES

- Very high power gain
- Low noise figure
- High transition frequency
- Emitter is thermal lead
- Low feedback capacitance.

## APPLICATIONS

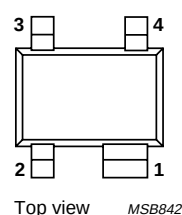
- RF front end
- Wideband applications, e.g. analog and digital cellular telephones, cordless telephones (PHS, DECT, etc.)
- Radar detectors
- Pagers
- Satellite television tuners (SATV)
- High frequency oscillators.

## DESCRIPTION

NPN double polysilicon wideband transistor with buried layer for low voltage applications in a plastic, 4-pin dual-emitter SOT343R package.

## PINNING

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | emitter     |
| 2   | base        |
| 3   | emitter     |
| 4   | collector   |



Marking code: P5.

Fig.1 Simplified outline SOT343R.

## QUICK REFERENCE DATA

| SYMBOL    | PARAMETER                 | CONDITIONS                                                                                                 | MIN. | TYP. | MAX. | UNIT |
|-----------|---------------------------|------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $V_{CBO}$ | collector-base voltage    | open emitter                                                                                               | –    | –    | 10   | V    |
| $V_{CEO}$ | collector-emitter voltage | open base                                                                                                  | –    | –    | 4.5  | V    |
| $I_C$     | collector current (DC)    |                                                                                                            | –    | 25   | 30   | mA   |
| $P_{tot}$ | total power dissipation   | $T_S \leq 103\text{ }^{\circ}\text{C}$                                                                     | –    | –    | 135  | mW   |
| $h_{FE}$  | DC current gain           | $I_C = 25\text{ mA}$ ; $V_{CE} = 2\text{ V}$ ; $T_j = 25\text{ }^{\circ}\text{C}$                          | 50   | 80   | 120  |      |
| $C_{re}$  | feedback capacitance      | $I_C = 0$ ; $V_{CB} = 2\text{ V}$ ; $f = 1\text{ MHz}$                                                     | –    | 95   | –    | fF   |
| $f_T$     | transition frequency      | $I_C = 25\text{ mA}$ ; $V_{CE} = 2\text{ V}$ ; $f = 2\text{ GHz}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$ | –    | 25   | –    | GHz  |
| $G_{max}$ | maximum power gain        | $I_C = 25\text{ mA}$ ; $V_{CE} = 2\text{ V}$ ; $f = 2\text{ GHz}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$ | –    | 20   | –    | dB   |
| $F$       | noise figure              | $I_C = 2\text{ mA}$ ; $V_{CE} = 2\text{ V}$ ; $f = 2\text{ GHz}$ ; $\Gamma_S = \Gamma_{opt}$               | –    | 1.2  | –    | dB   |

## CAUTION

This product is supplied in anti-static packing to prevent damage caused by electrostatic discharge during transport and handling. For further information, refer to Philips specs.: SNW-EQ-608, SNW-FQ-302A and SNW-FQ-302B.

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LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

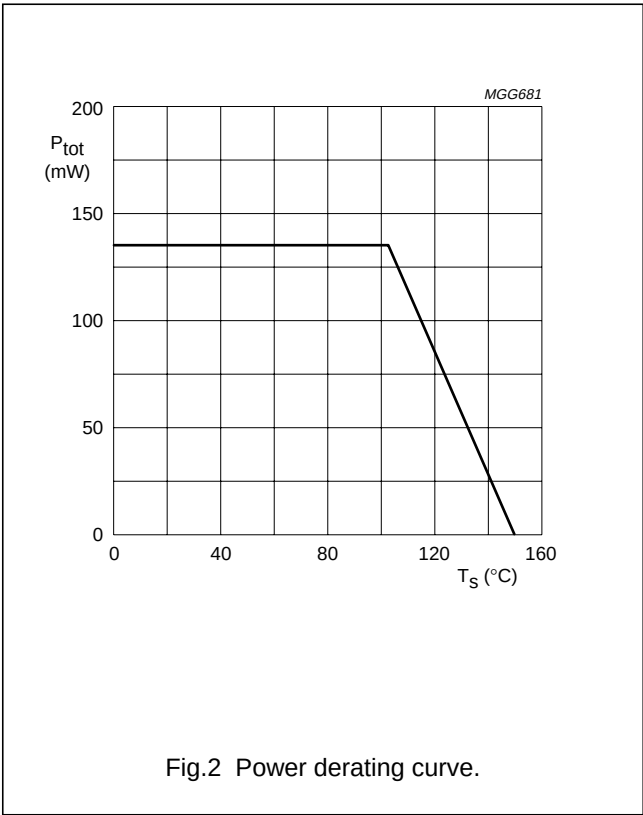
| SYMBOL           | PARAMETER                      | CONDITIONS                                 | MIN. | MAX. | UNIT |
|------------------|--------------------------------|--------------------------------------------|------|------|------|
| V <sub>CBO</sub> | collector-base voltage         | open emitter                               | –    | 10   | V    |
| V <sub>CEO</sub> | collector-emitter voltage      | open base                                  | –    | 4.5  | V    |
| V <sub>EBO</sub> | emitter-base voltage           | open collector                             | –    | 1    | V    |
| I <sub>C</sub>   | collector current (DC)         |                                            | –    | 30   | mA   |
| P <sub>tot</sub> | total power dissipation        | T <sub>s</sub> ≤ 103 °C; note 1; see Fig.2 | –    | 135  | mW   |
| T <sub>stg</sub> | storage temperature            |                                            | –65  | +150 | °C   |
| T <sub>j</sub>   | operating junction temperature |                                            | –    | 150  | °C   |

Note

1. T<sub>s</sub> is the temperature at the soldering point of the emitter pins.

THERMAL CHARACTERISTICS

| SYMBOL              | PARAMETER                                           | VALUE | UNIT |
|---------------------|-----------------------------------------------------|-------|------|
| R <sub>th j-s</sub> | thermal resistance from junction to soldering point | 350   | K/W  |



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## CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

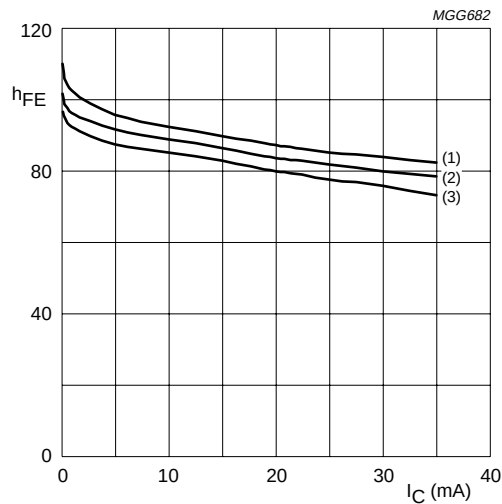
| SYMBOL        | PARAMETER                             | CONDITIONS                                                                                                               | MIN. | TYP. | MAX. | UNIT |
|---------------|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $V_{(BR)CBO}$ | collector-base breakdown voltage      | $I_C = 2.5\text{ }\mu\text{A}; I_E = 0$                                                                                  | 10   | –    | –    | V    |
| $V_{(BR)CEO}$ | collector-emitter breakdown voltage   | $I_C = 1\text{ mA}; I_B = 0$                                                                                             | 4.5  | –    | –    | V    |
| $V_{(BR)EBO}$ | emitter-base breakdown voltage        | $I_E = 2.5\text{ }\mu\text{A}; I_C = 0$                                                                                  | 1    | –    | –    | V    |
| $I_{CBO}$     | collector-base leakage current        | $I_E = 0; V_{CB} = 4.5\text{ V}$                                                                                         | –    | –    | 15   | nA   |
| $h_{FE}$      | DC current gain                       | $I_C = 25\text{ mA}; V_{CE} = 2\text{ V};$ see Fig.3                                                                     | 50   | 80   | 120  |      |
| $C_c$         | collector capacitance                 | $I_E = i_e = 0; V_{CB} = 2\text{ V}; f = 1\text{ MHz}$                                                                   | –    | 300  | –    | fF   |
| $C_e$         | emitter capacitance                   | $I_C = i_c = 0; V_{EB} = 0.5\text{ V}; f = 1\text{ MHz}$                                                                 | –    | 575  | –    | fF   |
| $C_{re}$      | feedback capacitance                  | $I_C = 0; V_{CB} = 2\text{ V}; f = 1\text{ MHz};$<br>see Fig.4                                                           | –    | 95   | –    | fF   |
| $f_T$         | transition frequency                  | $I_C = 25\text{ mA}; V_{CE} = 2\text{ V}; f = 2\text{ GHz};$<br>$T_{amb} = 25\text{ }^{\circ}\text{C};$ see Fig.5        | –    | 25   | –    | GHz  |
| $G_{max}$     | maximum power gain; note 1            | $I_C = 25\text{ mA}; V_{CE} = 2\text{ V}; f = 2\text{ GHz};$<br>$T_{amb} = 25\text{ }^{\circ}\text{C};$ see Figs 7 and 8 | –    | 20   | –    | dB   |
| $ S_{21} ^2$  | insertion power gain                  | $I_C = 25\text{ mA}; V_{CE} = 2\text{ V}; f = 2\text{ GHz};$<br>$T_{amb} = 25\text{ }^{\circ}\text{C};$ see Fig.8        | –    | 17   | –    | dB   |
| F             | noise figure                          | $I_C = 2\text{ mA}; V_{CE} = 2\text{ V}; f = 900\text{ MHz};$<br>$\Gamma_S = \Gamma_{opt};$ see Fig.13                   | –    | 0.8  | –    | dB   |
|               |                                       | $I_C = 2\text{ mA}; V_{CE} = 2\text{ V}; f = 2\text{ GHz};$<br>$\Gamma_S = \Gamma_{opt};$ see Fig.13                     | –    | 1.2  | –    | dB   |
| $P_{L1}$      | output power at 1 dB gain compression | $I_C = 25\text{ mA}; V_{CE} = 2\text{ V}; f = 2\text{ GHz};$<br>$Z_S = Z_{S\text{ opt}}; Z_L = Z_{L\text{ opt}};$ note 2 | –    | 12   | –    | dBm  |
| ITO           | third order intercept point           | $I_C = 25\text{ mA}; V_{CE} = 2\text{ V}; f = 2\text{ GHz};$<br>$Z_S = Z_{S\text{ opt}}; Z_L = Z_{L\text{ opt}};$ note 2 | –    | 22   | –    | dBm  |

## Notes

- $G_{max}$  is the maximum power gain, if  $K > 1$ . If  $K < 1$  then  $G_{max} = \text{MSG}$ ; see Figs 6, 7 and 8.
- $Z_S$  is optimized for noise;  $Z_L$  is optimized for gain.

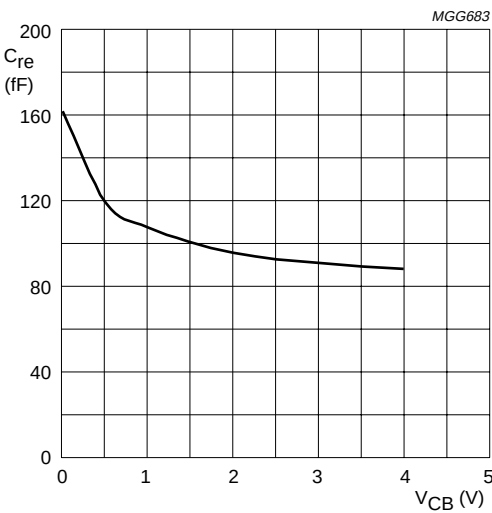
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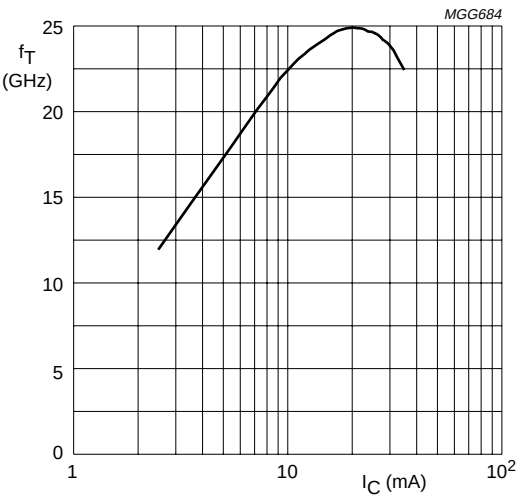
- (1)  $V_{CE} = 3$  V.
- (2)  $V_{CE} = 2$  V.
- (3)  $V_{CE} = 1$  V.

Fig.3 DC current gain as a function of collector current; typical values.



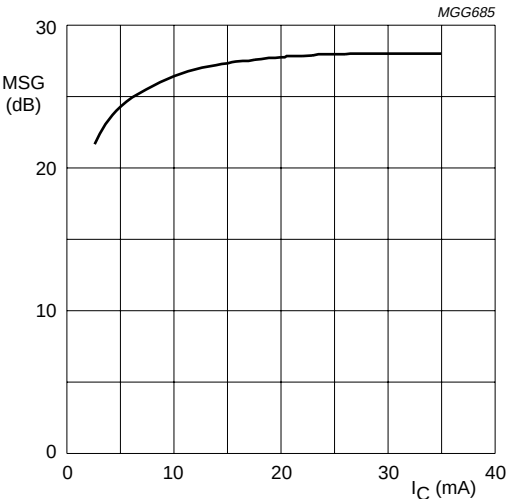
$I_C = 0$ ;  $f = 1$  MHz.

Fig.4 Feedback capacitance as a function of collector-base voltage; typical values.



$V_{CE} = 2$  V;  $f = 2$  GHz;  $T_{amb} = 25$  °C.

Fig.5 Transition frequency as a function of collector current; typical values.

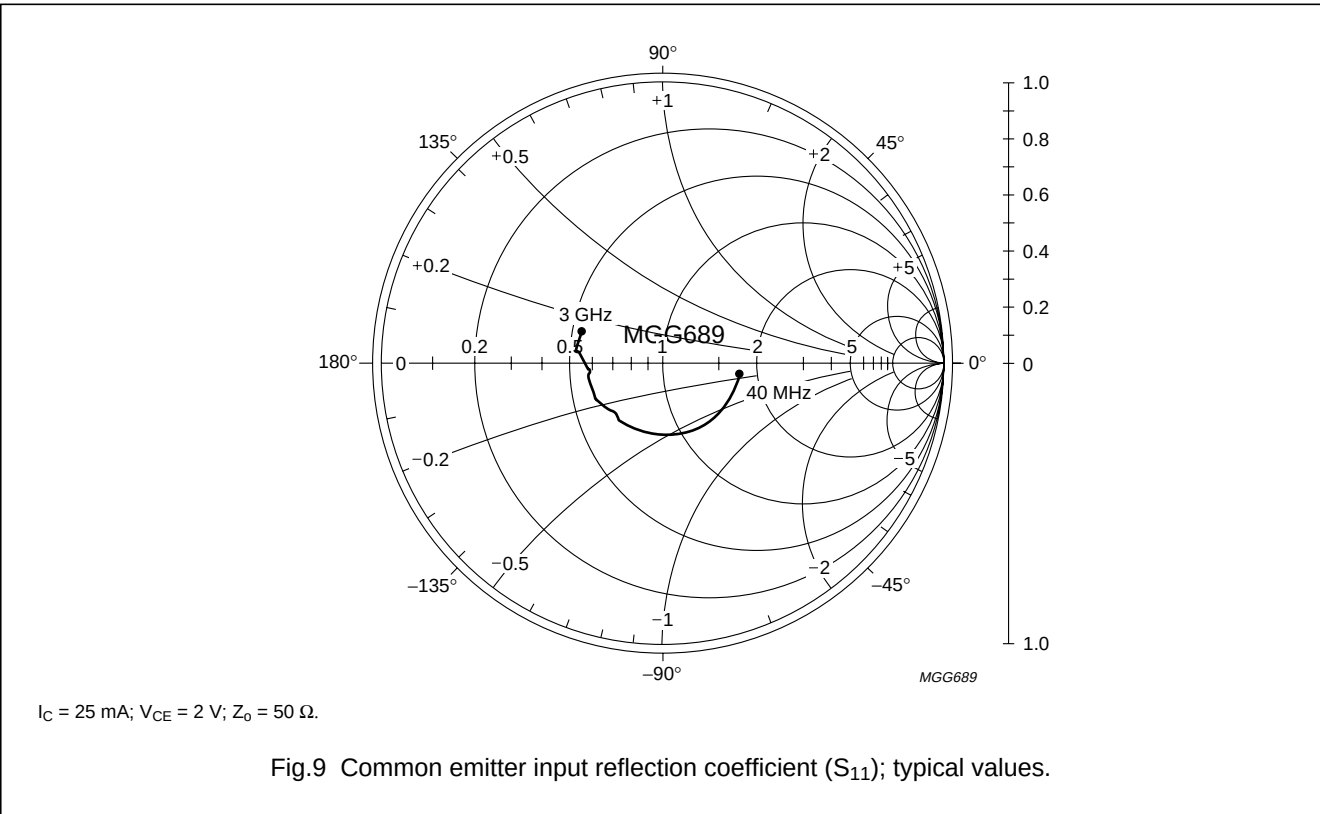
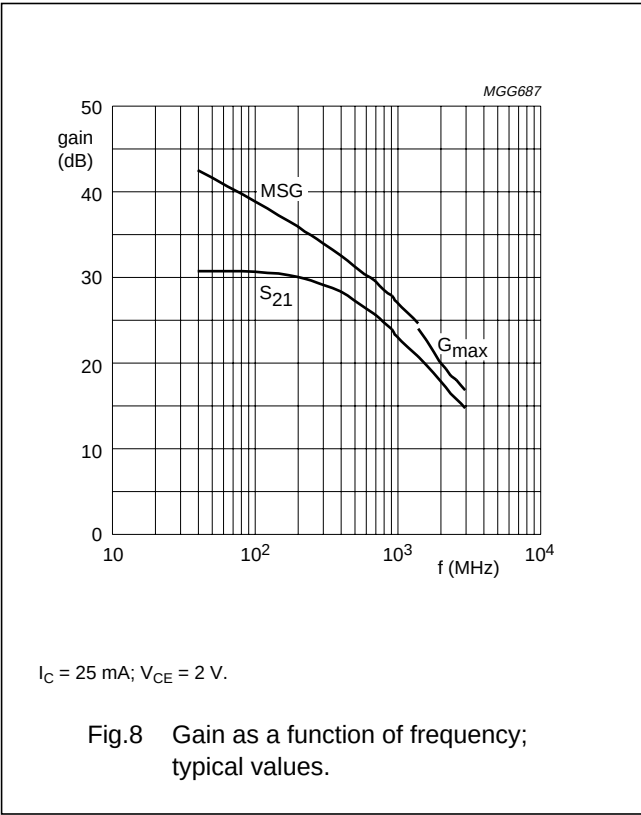
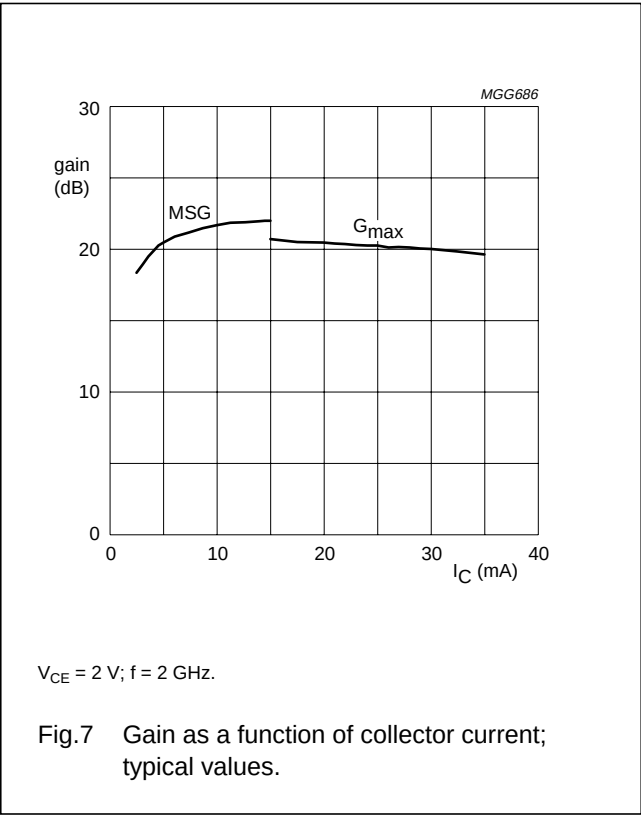


$V_{CE} = 2$  V;  $f = 900$  MHz.

Fig.6 Maximum stable gain as a function of collector current; typical values.

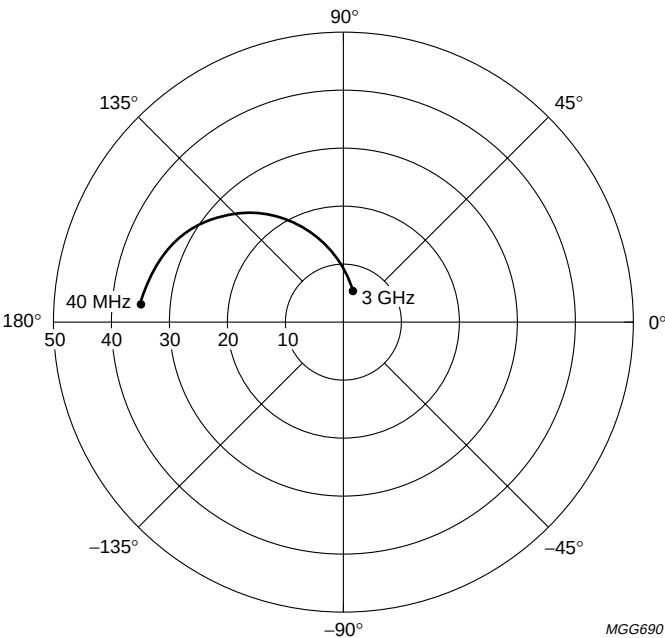
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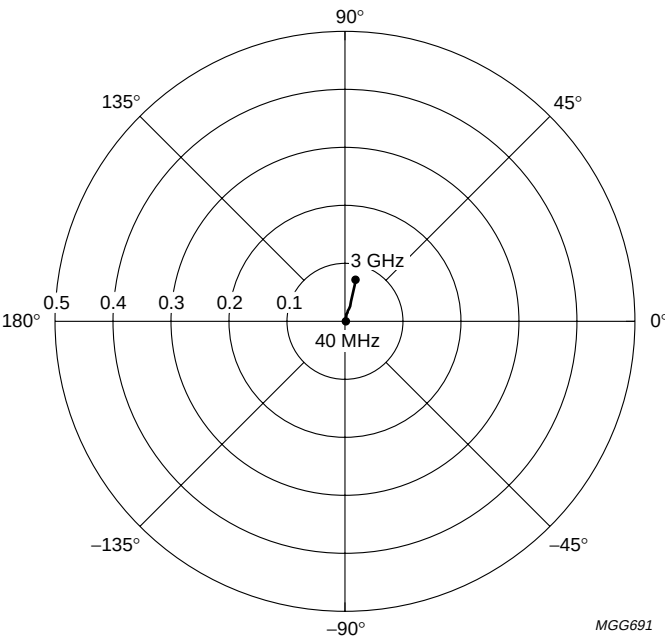
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$I_C = 25\text{ mA}$ ;  $V_{CE} = 2\text{ V}$ .

Fig.10 Common emitter forward transmission coefficient ( $S_{21}$ ); typical values.

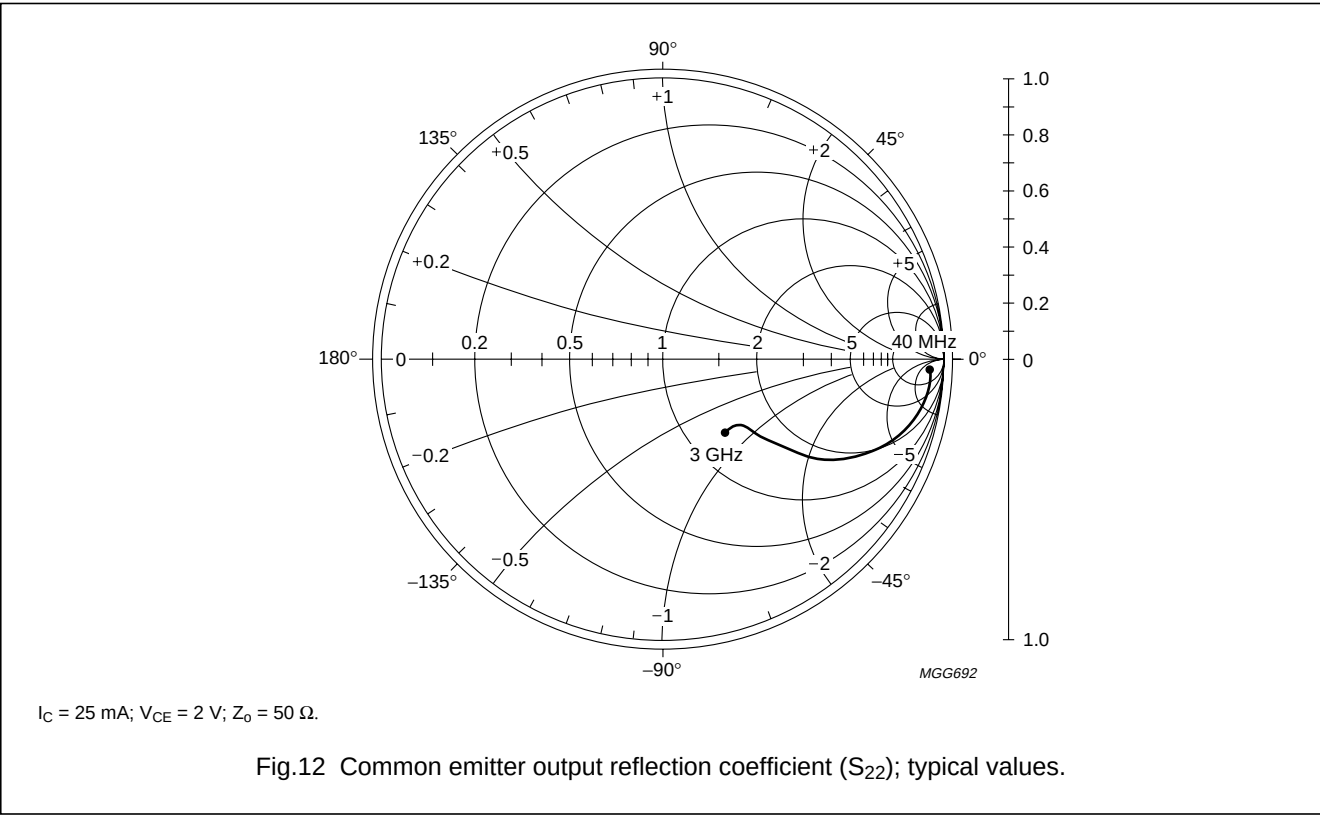


$I_C = 25\text{ mA}$ ;  $V_{CE} = 2\text{ V}$ .

Fig.11 Common emitter reverse transmission coefficient ( $S_{12}$ ); typical values.

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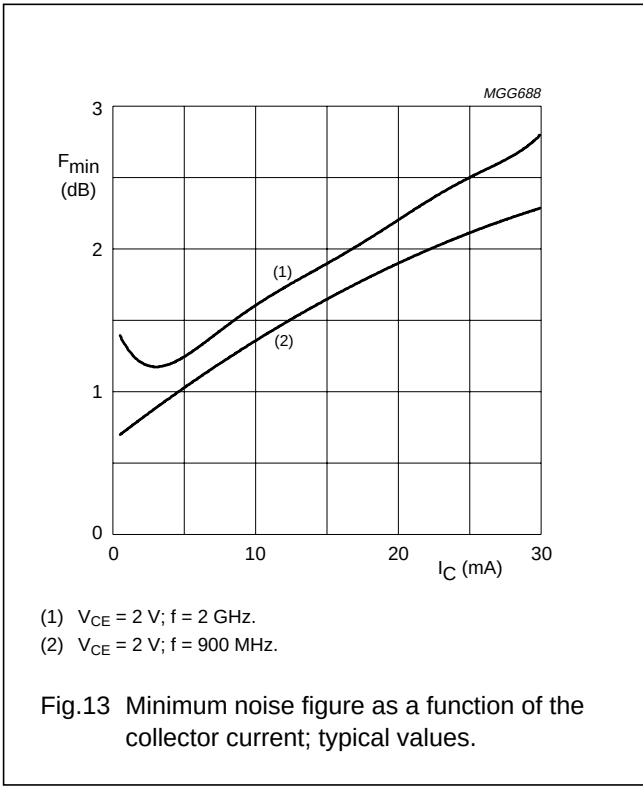
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Noise data

$V_{CE} = 2\text{ V}$ ; typical values.

| f<br>(MHz) | $I_C$<br>(mA) | $F_{min}$<br>(dB) | $\Gamma_{mag}$ | $\Gamma_{angle}$ | $r_n$<br>( $\Omega$ ) |
|------------|---------------|-------------------|----------------|------------------|-----------------------|
| 900        | 1             | 0.7               | 0.67           | 19.1             | 0.40                  |
|            | 2             | 0.8               | 0.48           | 17.8             | 0.27                  |
|            | 4             | 1                 | 0.28           | 11.7             | 0.24                  |
|            | 10            | 1.4               | 0.02           | -63.9            | 0.19                  |
|            | 15            | 1.6               | 0.11           | -162.4           | 0.18                  |
|            | 20            | 1.9               | 0.19           | -165.5           | 0.18                  |
|            | 25            | 2.1               | 0.25           | -166.3           | 0.19                  |
|            | 30            | 2.3               | 0.29           | -166.5           | 0.19                  |
| 2000       | 1             | 1.3               | 0.56           | 57.5             | 0.36                  |
|            | 2             | 1.2               | 0.43           | 57.2             | 0.25                  |
|            | 4             | 1.2               | 0.22           | 60.8             | 0.18                  |
|            | 10            | 1.6               | 0.06           | 137.4            | 0.19                  |
|            | 15            | 1.9               | 0.13           | -162.1           | 0.20                  |
|            | 20            | 2.2               | 0.17           | -155.5           | 0.20                  |
|            | 25            | 2.5               | 0.22           | -152.2           | 0.21                  |
|            | 30            | 2.8               | 0.27           | -150.8           | 0.25                  |



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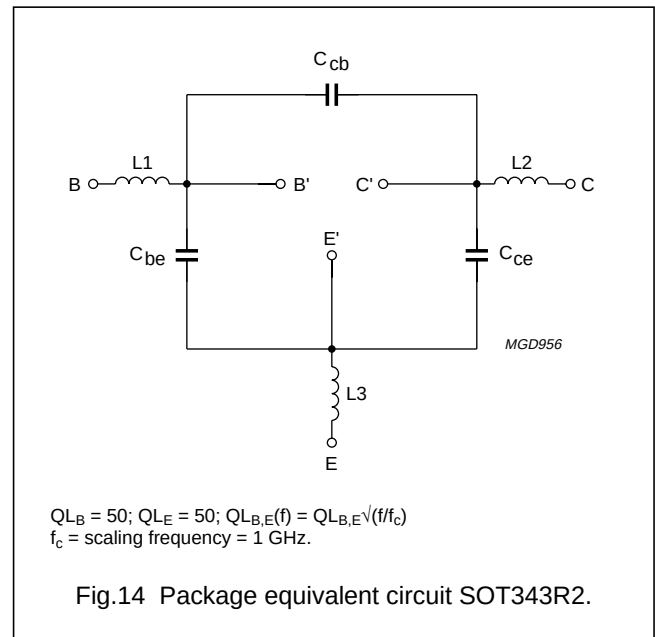
## SPICE parameters for the BFG425W die

| SEQUENCE No.      | PARAMETER | VALUE | UNIT       |
|-------------------|-----------|-------|------------|
| 1                 | IS        | 47.17 | aA         |
| 2                 | BF        | 145.0 | –          |
| 3                 | NF        | 0.993 | –          |
| 4                 | VAF       | 31.12 | V          |
| 5                 | IKF       | 304.0 | mA         |
| 6                 | ISE       | 300.2 | fA         |
| 7                 | NE        | 3.000 | –          |
| 8                 | BR        | 11.37 | –          |
| 9                 | NR        | 0.985 | –          |
| 10                | VAR       | 1.874 | V          |
| 11                | IKR       | 0.121 | A          |
| 12                | ISC       | 484.8 | aA         |
| 13                | NC        | 1.546 | –          |
| 14                | RB        | 14.41 | $\Omega$   |
| 15                | IRB       | 0.000 | A          |
| 16                | RBM       | 6.175 | $\Omega$   |
| 17                | RE        | 177.9 | m $\Omega$ |
| 18                | RC        | 1.780 | $\Omega$   |
| 19 <sup>(1)</sup> | XTB       | 1.500 | –          |
| 20 <sup>(1)</sup> | EG        | 1.110 | eV         |
| 21 <sup>(1)</sup> | XTI       | 3.000 | –          |
| 22                | CJE       | 310.9 | fF         |
| 23                | VJE       | 900.0 | mV         |
| 24                | MJE       | 0.346 | –          |
| 25                | TF        | 4.122 | ps         |
| 26                | XTF       | 68.20 | –          |
| 27                | VTF       | 2.004 | V          |
| 28                | ITF       | 1.525 | A          |
| 29                | PTF       | 0.000 | deg        |
| 30                | CJC       | 137.7 | fF         |
| 31                | VJC       | 556.9 | mV         |
| 32                | MJC       | 0.207 | –          |
| 33                | XCJC      | 0.500 | –          |
| 34 <sup>(1)</sup> | TR        | 0.000 | ns         |
| 35 <sup>(1)</sup> | CJS       | 667.5 | fF         |
| 36 <sup>(1)</sup> | VJS       | 418.3 | mV         |
| 37 <sup>(1)</sup> | MJS       | 0.239 | –          |
| 38                | FC        | 0.550 | –          |

| SEQUENCE No.         | PARAMETER | VALUE | UNIT     |
|----------------------|-----------|-------|----------|
| 39 <sup>(2)(3)</sup> | $C_{bp}$  | 145   | fF       |
| 40 <sup>(2)</sup>    | $R_{sb1}$ | 25    | $\Omega$ |
| 41 <sup>(3)</sup>    | $R_{sb2}$ | 19    | $\Omega$ |

## Notes

- These parameters have not been extracted, the default values are shown.
- Bonding pad capacity  $C_{bp}$  in series with substrate resistance  $R_{sb1}$  between B' and E'.
- Bonding pad capacity  $C_{bp}$  in series with substrate resistance  $R_{sb2}$  between C' and E'.



## List of components (see Fig.14)

| DESIGNATION | VALUE | UNIT |
|-------------|-------|------|
| $C_{be}$    | 80    | fF   |
| $C_{cb}$    | 2     | fF   |
| $C_{ce}$    | 80    | fF   |
| L1          | 1.1   | nH   |
| L2          | 1.1   | nH   |
| L3 (note 1) | 0.25  | nH   |

## Note

- External emitter inductance to be added separately due to the influence of the printed-circuit board.

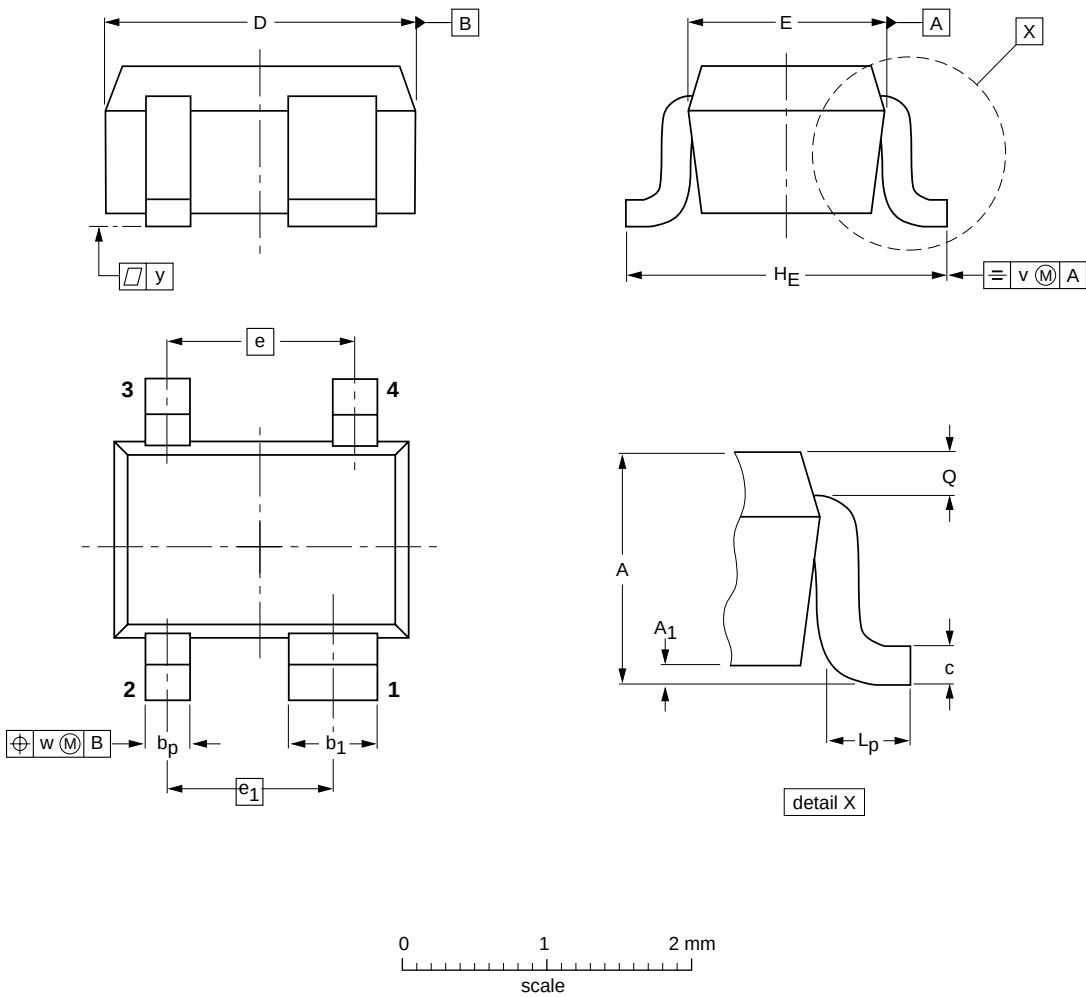
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PACKAGE OUTLINE

Plastic surface mounted package; reverse pinning; 4 leads

SOT343R



DIMENSIONS (mm are the original dimensions)

| UNIT | A          | A <sub>1</sub><br>max | b <sub>p</sub> | b <sub>1</sub> | c            | D          | E            | e   | e <sub>1</sub> | H <sub>E</sub> | L <sub>p</sub> | Q            | v   | w   | y   |
|------|------------|-----------------------|----------------|----------------|--------------|------------|--------------|-----|----------------|----------------|----------------|--------------|-----|-----|-----|
| mm   | 1.1<br>0.8 | 0.1                   | 0.4<br>0.3     | 0.7<br>0.5     | 0.25<br>0.10 | 2.2<br>1.8 | 1.35<br>1.15 | 1.3 | 1.15           | 2.2<br>2.0     | 0.45<br>0.15   | 0.23<br>0.13 | 0.2 | 0.2 | 0.1 |

| OUTLINE<br>VERSION | REFERENCES |       |      |  | EUROPEAN<br>PROJECTION | ISSUE DATE |
|--------------------|------------|-------|------|--|------------------------|------------|
|                    | IEC        | JEDEC | EIAJ |  |                        |            |
| SOT343R            |            |       |      |  |                        | 97-05-21   |

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**DEFINITIONS**

| <b>Data Sheet Status</b>                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Objective specification                                                                                                                                                                                                                                                                                                                                                                                                                                   | This data sheet contains target or goal specifications for product development.       |
| Preliminary specification                                                                                                                                                                                                                                                                                                                                                                                                                                 | This data sheet contains preliminary data; supplementary data may be published later. |
| Product specification                                                                                                                                                                                                                                                                                                                                                                                                                                     | This data sheet contains final product specifications.                                |
| <b>Limiting values</b>                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                       |
| Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability. |                                                                                       |
| <b>Application information</b>                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                       |
| Where application information is given, it is advisory and does not form part of the specification.                                                                                                                                                                                                                                                                                                                                                       |                                                                                       |

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These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

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